HABITAT USE BY NEARCTIC MIGRANTS IN THE CHARLESTON HARBOR AREA

Project: CHP #93 - 1.4. Habitat Identification - Birds (Neotropical migrants)

Final Report

by

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ABSTRACT

Nearctic migrants (bird species that breed in North America and winter in subtropical and tropical areas north of the equator) move through Charleston Harbor on their southward flight. Anecdotal information indicated that large numbers of migrants congregated in certain sites around the harbor. The study was designed to determine 1) the magnitude of autumn migration of Passeriformes (perching birds); 2) whether migrants are more common in one area than in another; 3) species composition, age structure, length of stay, and physiological state of the migrant population. Four sampling sites were established, two on barrier islands next to the Atlantic Ocean, and two farther inland, one at the northern end of Charleston Harbor and one on the Stono River.

About the same numbers of birds migrate through Charleston Harbor as do through other southern coastal sites for which data have been published. No significant differences were found between stations in the magnitude of migration. It is possible that the more inland stations had a higher volume of migration of the most common species (Common Yellowthroat, Gray Catbird and Palm Warbler), but the differences may be due to variation in availability of microhabitat (grass-shrub ecotone).

Although all stations had similar numbers of the three most common species, overall species richness was highest at the barrier island stations. Data on length of stay, weight gain, and composition indicate, however, that the barrier island habitats were of marginal suitability. It is hypothesized that many hatch-year birds, blown off course during their nocturnal flight, are concentrated in scrubland along the immediate coast at daybreak. Because of the relatively low quality of barrier island scrub habitat, these migrants appear to rapidly relocate to nearby wooded habitats on the mainland. Further research is needed to test this hypothesis.

Taken together, the results of the study indicate that in the Charleston Harbor area migration occurs evenly over a broad front. Within coastal scrub, the most common wooded habitat fringing the harbor, no differences were found among four potential stopover sites in concentrations of migrants. Larger numbers of species were recorded on the barrier islands than at stations farther inland. Because of this, several extensive scrub tracts, notably the southern end of Sullivan's Island, and the northern end of Folly Beach, deserve continued protection.

INTRODUCTION

Most insectivorous songbirds that breed in North America spend the winter in the Caribbean Basin, Central America and northern South America (nearctic migrants). Recent research (reviewed by Askins et al. 1990) has demonstrated that many of these once common species, primarily those of the order Passeriformes (perching birds), have declined in the last 20-30 years. The reasons for this decline are not yet fully understood. One factor that affects the survival of these species is the availability of suitable habitat during their autumn passage to the tropics (Moore et al. 1993). Most songbirds migrate at night, and after they land in the early morning, require areas for feeding and resting. Coastal stopover sites may be particularly important, because weather conditions and topography tend to concentrate birds into narrow corridors. Information about the habitat use of nocturnal migrants during their passage through the coastal region of the southeastern United States is inadequate. As human populations increase in the coastal zone, it is advisable to address the question of what type and how much natural stopover habitat should be preserved.

The objective of the study was to determine how different geographic points around Charleston Harbor are used by nearctic migrants. Based on published information about the behavior of autumn migrants in northeastern North America (Richardson 1978, Able 1980, Ralph 1981, Wiedner et al. 1992), I predicted that during the daylight periods, southbound migrants along the South Carolina Coast would follow topographic features ("leading lines") as they moved through the harbor area. If autumn migrants follow coastal topographic features they would tend to be concentrated on peninsulas. If it could be established that significant numbers of migrants occurred in certain areas, and if such areas were limited, then it would be possible to argue that these sites deserved special protection. The information gathered in the study could then be used to help formulate land-use strategies in the increasingly urbanized Charleston Harbor area.

When they are flying at night, few birds apparently use topographic features to navigate (Able 1980). During the daytime, however, migrants often make short-range movements to resting or feeding areas near the point of their morning landing (Wiedner et al. 1992; pers. obs.). During this time, topographic features such a larger bodies of water may influence the movements of birds, leading them to concentrate in restricted areas such as peninsulas. Further, many birds that migrate at night along the coast may drift off course due to shifts in wind direction ("wind drift"; Richardson 1978), and find themselves over open ocean at dawn. The migrants may then reorient in a northerly direction, enabling them to reach the nearest coastline. Such redirected movements would further concentrate birds along the immediate coast. Under these circumstances, some areas could be important resting areas for bird exhausted by a return flight often made against unfavorable head winds (see, however, Rappole and Warner 1976).

The main hypothesis is that migrants occupying the Charleston Harbor area after a nocturnal flight would be concentrated on southward oriented peninsulas. I predict 1) that the Hog Island peninsula, at the confluence of the Wando River and Intercoastal Waterway, would have the largest concentration of migrants; 2) the southwestern end of Sullivan's Island would have the second-highest concentration; 3) Little Folly Island, at the northeastern end of Folly Beach, would be next in importance; 4) a more inland, non-peninsular, station on the Stono River (James Island), 5 km from the Atlantic Ocean, would have the fewest migrants.

METHODS

To fulfill the objectives outlined above, I established four mist-netting stations at points surrounding Charleston Harbor. Three sites were on peninsulas or on tips of islands. Two sampling point (James Island and Hog island) were slightly inland, and acted as controls for the two stations located on the immediate coast (Figure 1).

Each station was operated during the August-November migration period. Black nylon mist-nets, 12-m long and 3-m high, were placed in narrow (2-m wide) lanes cut through coastal scrub/grassland. All the netting sites were similar in vegetation density, height (2-5 m), and species composition (wax myrtle, *Myrica cerifera*; wild black cherry, *Prunus serotina*; red cedar, *Juniperus virgiana*; live oak, *Quercus virgiana*; hackberry, *Celtis laevigata*; groundsel, *Baccharis halimifolia*; greenbrier, *Smilax* spp.; blackberry, *Rubus argutus*).

In order to standardize the trapping procedure among stations, all nets were placed perpendicular to the nearest body of water. At each station, nets were operated from dawn to midday, but only when there was

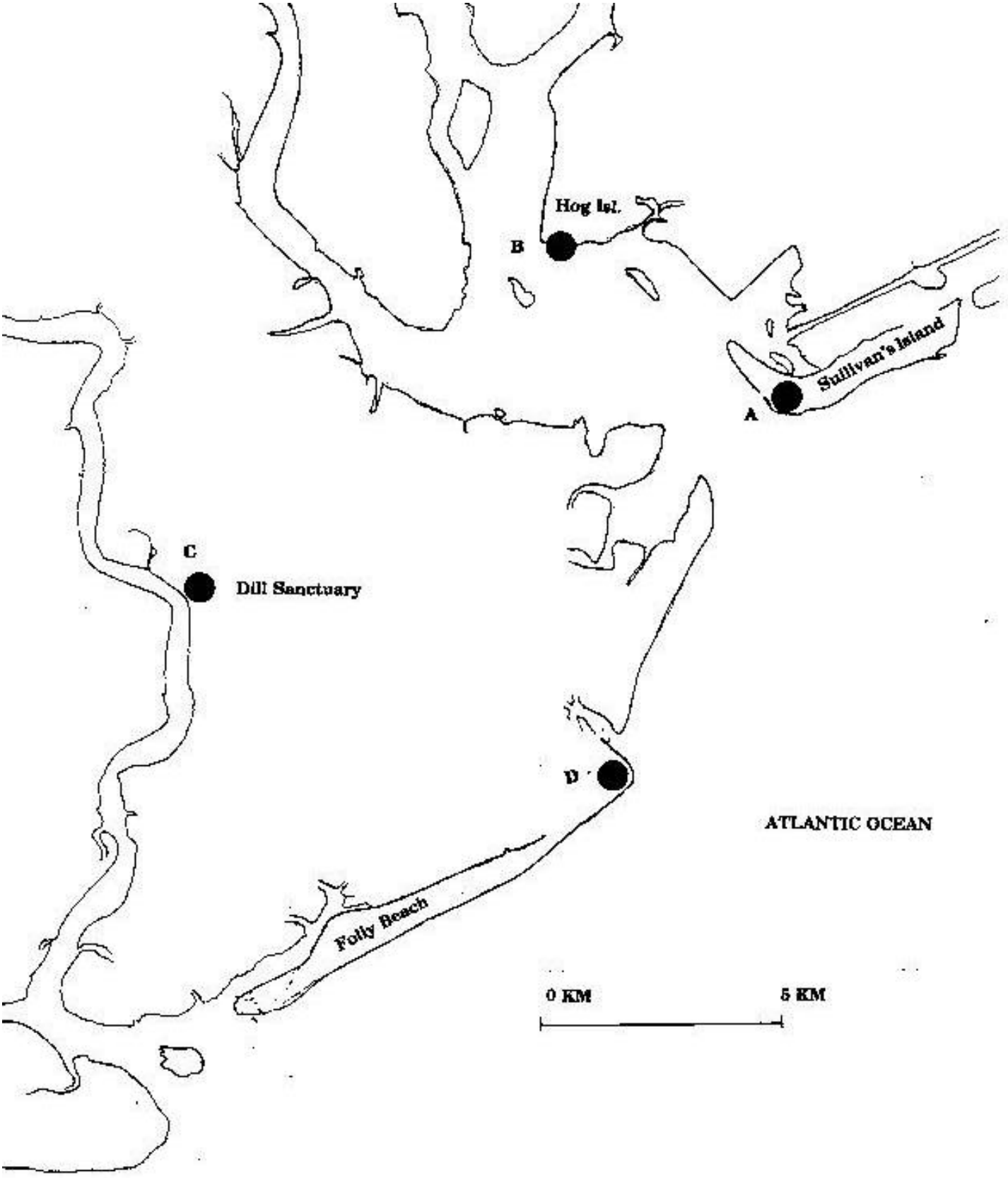

Figure 1. Location of sampling stations around Carleston Harbor. A=Sullivans Island; B=Hog Island ("Patriot's Point"; C=James Island; D=Folly Beach.

no rain, and when the wind was less than 20 km per hr. When netting was interrupted by bad weather, the data gathered were not included if nets were open for less than 2.5 hr. Nets were checked on the same schedule, usually every 15-30 min, the exact interval depending on the volume of migration. Sampling effort was measured as net-hours: the amount of time that one 12-m mist net was operated. For the analysis, I include only capture data for the September and October, the main period of migration for insectivorous passerines in coastal South Carolina (Post and Gauthreaux 1983, McNair and Post 1989).

After a bird was taken from the mist-net, my assistants and I recorded species, age and sex, and then affixed a numbered US Biological Survey band, and released the individual near the capture point. Some individuals were weighed and measured. Because of the large numbers of birds captured on some days, not all were banded, but instead were released immediately at the net. A tally was kept of the species and numbers of all unmarked releases. Volume of migration was expressed as total birds captured per net-hr, whether the bird was banded or not.

The stations were operated intermittently during the period 1983-1995. In most years (1983, 1985, 1987, 1990, 1993, 1994), I operated only one station. In 1984 and 1995 two stations were operated at the same time.

RESULTS

During the study period, 21310 birds were captured on 367 days (18701 net-hr). Of these, 16304 (76.5%) were nearctic migrants. The nearctic migrants composed 53.2% of the 124 species captured (Table 1).

Table 1. Numbers of nearctic migrants captured at four localities around Charleston Harbor, 1983-1995.

Location	No. of migrants captured per 100 mist-net hr per d per yr	Total no. of nearctic migrants captured	(X;range)
James I.	4	4612	77.8; 47.6-98.7
Folly Beach	2	1921	63.3; 54.7-71.9
Hog I	4	8558	131.0; 72.4-197.9
Sullivan's I.	2	3306	62.9; 61.1-65.6

I detected variation in numbers of nearctic migrants captured per net-hr among the various stations (Fig. 2). For example, capture rate ranged from 240.4 birds per 100 net-hr (Hog Island, 1985) to 68.3 birds per 100 net-hr (James Island, 1994; Table 1). Comparing all the data collected over the eight-year study period, it appears that Hog Island had the highest concentration of nearctic migrants, followed by James Island. Sullivan's Island and Folly Beach had about the same numbers of nearctic transients (Table 2). The data also reveal considerable

Table 2. Numbers of nearctic migrants captured per 1000 net-hours at two stations on immediate coast (Sullivan's island and Folly Beach) and at two more inland stations (Hog Island and James Island). Total net-hours: Hog Island, 2354; Sullivan's Island, 2142; James Island, 1068; Folly Beach, 922.

	1984		1995	
Species	Hog Island	Sullivan's I.	James I.	Folly Beach
American Redstart	38.2	35.9	15.9	40.2
Black-and-White Warbler	6.4	17.7	1.9	9.8
Blue Grosbeak	2.1	0.9	7.5	1.1
Blackpoll Warbler	0.4	0	0	5.4
Black-throated Blue Warbler	0.8	7.0	7.5	45.6
Cape May warbler	0.8	0.5	3.7	18.5
Common Yellowthroat	488.1	192.3	181.6	136.8
Gray Catbird	110.9	39.2	146.1	92.3
Indigo Bunting	13.2	28.9	228.5	0
Magnolia Warbler	2.1	1.9	0.9	7.6
Northern Parula	0.4	3.3	1.9	9.8
Northern Waterthrush	37.4	66.8	2.8	5.4
Ovenbird	4.7	4.2	2.8	6.5
Painted Bunting	20.8	18.7	22.5	5.4
Prairie Warbler	16.6	43.9	11.2	22.8
Prothonotory Warbler	3.4	1.9	0	0
Red-eyed Vireo	17.4	36.4	18.7	36.9
Swainson's Thrush	0.8	3.3	1.9	3.3
Trail's Flycatcher	15.3	4.7	1.9	1.1
Veery	6.4	2.8	2.8	3.3
White-eyed Vireo	87.5	14.9	11.2	26.1
Worm-eating Warbler	0.4	0	0	3.3
Palm Warbler (Western)	39.9	92.4	227.5	23.9
Yellow Warbler	4.7	15.4	0	0
Number captured per 1000 net-hr per day				
	1297±220	681±116	1002±141	1052±333 1
	(**N**=41)	(**N**=32)	(**N**=26)	(**N**=19)

Mean number captured per day ±standard error of mean; **N** = number of days.

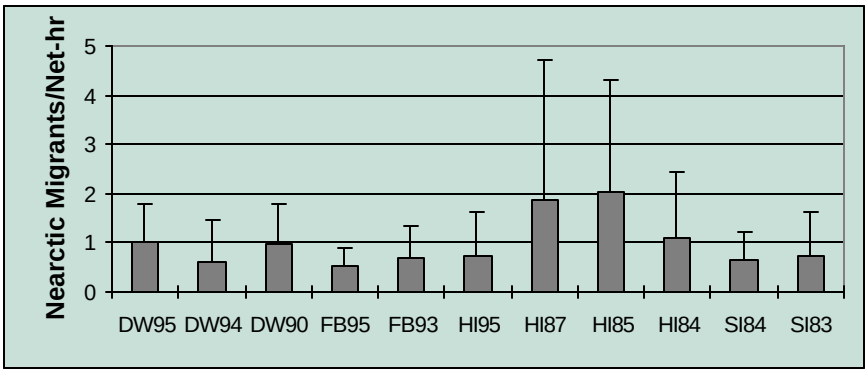

Figure 2. Numbers (mean ± 1 SD) of nearctic migrants captured per net-hour at four stations during 11 sampling-years.

variation between years at the same sites; for example, the capture rate at Hog Island ranged from 78.8 (1995) to 240.4 (1985).

Because of the high interannual variation, and the relatively short-term nature of the study, most data cannot be used to address the question of whether one site had a higher volume of transient nearctic migrants than another. In 1984 and 1995, however, two station were operated during the same period, enabling me to address the question of whether stations differed in species composition.

Community structure. Species compositions at the inland and coastal stations were different in the two years for which comparisons were possible (Table 2). In 1984, 16 species were common enough (numbers of each species captured ≥5) to both Hog Island and Sullivan's Island to allow their use in a statistical test. The 3657 individuals captured were not

proportionally distributed between the two stations (chi-squared = 710.8; **P**<0.001 **df**=15). The same comparison performed in 1995, and involving 11 species common to James Island and Folly Beach (Table 2), also revealed a highly significant difference in overall species composition (chi-squared = 227.3; **P**<0.001; **df**=10).

The large differences between localities in community composition result from variation in the relative abundance of a few common, but not top-ranked species. At all stations, the common Yellowthroat (*Geothlypis trichas*) was the most abundant nearctic migrant (Table 3). The Gray Catbird (*Dumetella carolinensis*) and the Western Palm Warbler (*Dendroica palmarum*) alternated as second- or third-ranked in abundance. The relative importance of these two species at a given station appeared to be related to habitat preferences. Catbirds were most often captured in net lanes placed through dense scrub patches, whereas Palm Warblers favored grass-scrub ecotones. Among the remaining common species (each with ≥5% of total captures), the American Redstart (*Setophaga ruticilla*), White-eyed Vireo (*Vireo griseus*) and Indigo Bunting (*Passerina cyanea*) were similarly-ranked at the four stations. The distribution of the Northern Waterthrush (*Seiurus noveboracensis*) appeared to vary between sites. The species made up 6% of the total captured on Sullivan's Island, but only about 2% at each of the other four sites. Similarly, the Cape May Warbler (*Dendroica tigrina*) was common on Folly Beach (>4% of total captures), but was absent or uncommon (<1%) at the other stations.

The most abundant species at all stations were short-distance migrants; that is, birds whose wintering range is in the southeastern United States (Hagan et al. 1992). These species, for example the Common Yellowthroat, Western Palm Warbler and Gray Catbird, are in or near their normal winter range when they reach coastal South Carolina. Species that winter in the Antilles and northern South America, for example the Black-throated Blue Warbler, Black-and-white Warbler (*Mniotilta varia*) and the Red-eyed Vireo (*Vireo olivaceus*), were relatively uncommon (each less than 3% of captures). Only one long-range migrant, the American Redstart, was ranked among the top five species. Even its numbers, however, made up less than 6% of the captures (Table 3). No threatened or endangered species were captured during the 8-year study.

Species richness. Overall, the three top-ranked species accounted for 68.8% of all the birds captured. In addition, 65 other species of nearctic migrants were captured. To examine the question of whether the sampling stations differed in species richness, it is possible to compare actual numbers of species captured at each station, if correction is made for the different size of each community; i.e., numbers captured. In cases where sample sizes are not equal, a statistical method known as rarefaction may be used to allow comparisons of species numbers between communities (Hurlbert 1971). The analysis (Fig. 3) shows that Folly Beach consistently had the highest expected species richness, followed by Sullivan's Island and James Island. Hog Island consistently had the lowest expected species richness.

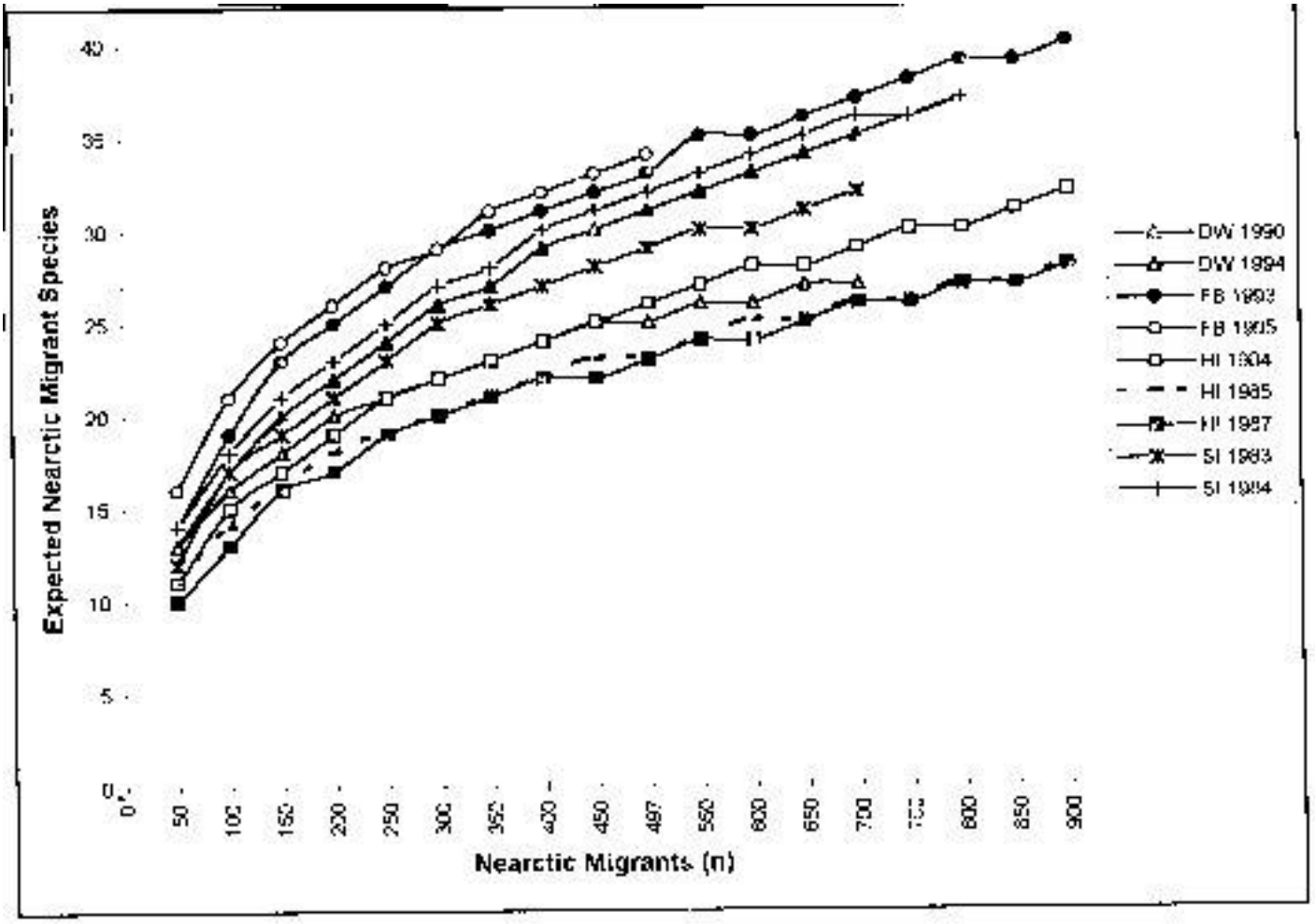

Figure 3 Species richess adjusted for sample size by rarefaction (expected number of nearctic migrant species versus total individuals captured).

Length of stay. Only a few banded birds were recaptured in the vicinity of the banding stations. At the two more inland stations (Hog Island and James Island), the average length of stay for 55 individual birds of 10 nearctic species was 5.36±0.57(SE) d, range 1-20 d. By contrast, the length of stay of 62 individuals of 12 species at the more coastal stations (Sullivan's Island and Folly Beach) was 3.79±0.39 d, range 1-14 d. These periods are not significantly different (**P**>0.05).

Only one species, the White-eyed Vireo, was recaptured frequently enough at different sites to permit a within-species comparison. The average length of stay of 16 White-eyed Vires on the immediate coast was 4.31±0.58 d, as compared with 6.30±1.24 d for 20 vireos at the two inland stations. Although the data point in the direction of a longer stopover for vireos at the more interior station, because of high variability of the data, the means are not significantly different.

Weight gain. Change in the weight of recaptured birds is another means of assessing the relative suitability of stopover sites. If an individual stays in one area, and rebuilds its energy reserves rapidly, this presumably indicates that the stopover site is highly suitable (Moore and Simons 1992). The average daily weight gain for the

coastal stations, expressed as a percentage of total weight, was +0.50±0.54(SE)% (**N**=36 birds). The comparable figure for the inland stations was +0.72±0.50% per day (**N**=42).

Table 3. Fifteen most common species of nearctic migrants at four stations around Charleston Harbor during September-October, 1983-1995.

	Station (Species, percentage of total captured)				
Rank	James I.	Folly beach	Hog I.	Sullivan's I.	Overall[1]
1	COYE (32.2)	COYE (33.8)	COYE (41.1)	COYE (33.7)	COYE (37.7)
2	WPWA (17.1)	GRCA (18.9)	GRCA (24.8)	WPWA (23.4)	GRCA (18.4)
3	INBU (13.8)	WPWA (9.0)	WPWA (9.0)	GRCA (7.5)	WPWA (12.7)
4	GRCA (9.1)	AMRE (8.9)	WEVI (6.6)	NOWA (6.0)	AMRE (5.6)
5	AMRE (7.1)	CMWA (4.3)	AMRE (4.6)	INBU (5.2)	WEVI (4.6)
6	PABU (4.5)	REVI (4.1)	INBU (2.3)	AMRE (4.8)	INBU (4.4)
7	REVI (3.7)	WEVI (3.1)	NOWA (2.3)	REVI (4.1)	NOWA (2.7)
8	PRAW (3.6)	BTBW (2.9)	PRAW (1.7	PRAW (3.6)	REVI (2.7)
9	WEVI (1.9)	NOPA (2.2)	PABU (1.6)	WEVI (2.5)	PRAW (2.4)
10	NOWA (1.7)	PRAW (2.1)	REVI (1.6)	BTBW(1.6)	PABU (1.8)
11	YWAR (1.5)	VEER (1.7)	YWAR (1.5)	YWAR (1.5)	YWAR (1.3)
12	BAWW (0.7)	BAWW (1.6)	TRFL (1.2)	BAWW (1.4)	TRFL (O.8)
13	MAWA (0.6)	MAWA (1.6)	VEER (0.5)	PABU (1.0)	CMWA (0.8)
14	TRFL (0.6)	NOWA (1.6)	BAWW (0.3)	OVEN (0.8)	BAWW (0.8)
15	OVEN (0.5)	SWTH (1.4)	SWTH (0.3)	SWTH (0.7)	BTBW (0.8)
-	OTHR[2] (1.4)	OTHR (2.8)	OTHR (0.6)	OTHR (2.2)	OTHR (2.5)
TOTAL CAPTURED	2046	1235	6769	2193	2799_1

Species codes: AMRE=American Redstart; BAWW= Black-and-white Warbler; BTBW=Black-throated Blue Warbler; CMWA= Cape May Warbler; COYE=Common Yellowthroat; GRCA=Gray Catbird; INBU=Indigo Bunting; MAWA=Magnolia Warbler; NOPA=Northern Parula; NOWA=Northern Waterthrush; OVEN=Ovenbird; PABU=Painted Bunting; PRAW=Prairie Warbler; REVI=Red-eyed Vireo; SWTH=Swainson's Thrush; TRFL=Traill's Flyycatcher; VEER=Veery; WEVI=White-eyed Vreo; WPWA=Western Palm Warbler; YWAR=Yellow Warbler.

[2] Remaining percentages of all other nearctic migrants captured.

Among White-eyed Vireos alone, daily coastal weight change for nine individuals was +0.74±0.69%, as opposed to +1.63±0.79% for 10

White-eyed Vireos at the inland sites. The apparently more rapid weight gain at the inland sites, although not significant, does imply that they were better stopover areas than were points on the immediate coast.

Age ratio. Most species migrating on the Atlantic coast exhibit a "coastal effect" in the age structure of the population: 85-95% of the birds are hatch-year, as compared to 65-70% inland (Ralph 1981). It is not adaptive for migrants to fly at night near the ocean, because of the possibility of their being drifted over open water by shifting winds. Inexperienced (hatch-year) migrants may engage in this form of maladaptive migration (Drury and Keith 1962). Adults presumably have gained enough experience in orientation to use overland routes. If displaced by wind, experienced birds that do migrate at night along the coast are able to reorient. Assuming that most nocturnal migrants that are drifted over the ocean during the night are hatch-year birds, and that some are able to reorient to the nearest land at dawn (Richardson 1978), it would be expected that a higher proportion of hatch-year birds would be captured on the immediate coast, in comparison to more inland stations. As expected, at all stations, a high proportion (for most species about 90%) of birds were young of the year (Table 4). The results, however, show a difference in age ratios between the inland and coastal station for only one species, the American Redstart. The difference was opposite from the predicted direction, as a significantly higher proportion of adults was captured at Folly Beach than at James Island (Table 4).

Percentage recaptured. The proportions of nearctic migrants that were captured, marked, and recaptured one day or more later were low. On Sullivan's Island in 1984, 4.83% of 973 marked birds were recaptured. Comparable figures for other stations are as follows: Folly beach (1993): 3.61% of 665; James Island (1990): 1.73% of 347; Hog Island (1985): 3.64% of 1401; Hog Island (1987): 1.63% of 1103. There appears to be little difference between stations, although small sample sizes preclude statistical tests.

Table 4. Age ratios of nearctic migrants at two station operated on the same days in September-October 1995, one on the immediate coast, and one 5 km inland.

	Coastal station (Folly Beach)		Inland station (James Island)	
Species	Total Examined	Percentage Hatch-year	Total Examined	Percentage Hatch-year
Gray Catbird	65	90.8	97	97.9
White-eyed Vireo	17	88.2	12	83.3
Red-eyed Vireo	25	88.0	18	94.4
Common Yellowthroat	67	95.5	44	88.6
American				

Redstart	39	76.9	*	16	100.0
Palm Warbler[2]	10	100.0		66	96.7

[1] Fisher Exact Probability = 0.03
[2] "Western" race

DISCUSSION

I predicted 1) that Hog Island, at the confluence of the Wando River and Intracoastal Waterway, would have the largest concentration of migrants; 2) the southwest end of Sullivan's Island would have the second-highest concentration; 3) Little Folly Island, at the NE end of Folly Beach, would be next in importance; 3) a more inland station, next to the Stono River, and 5 km from the Atlantic Ocean, would have the fewest migrants.

The results show no clear-cut differences between sampling stations. In the Charleston Harbor area, migration occurs over a broad front, and, except for several abundant species, there is little concentration of migrants at any one site. Differences between banding stations may be explained for the most part by the different habitat preferences of several very common species. These differences appear to be site-independent.

Correlative data from published research suggest that habitat selection occurs during migration: migrants prefer certain habitat types (Hutto 1985, Moore et al. 1990, Winkler et al. 1992). The limited scope of this study does not allow me to address the question of habitat selection. To answer the question of whether one geographical area was different from another, I held habitat (disturbed coastal scrub) constant. Studies on the Gulf of Mexico, however, suggest that scrub-shrub habitat may be used more often than other habitats available within a limited geographical area (Moore et al 1993). Unfortunately I was unable to sample other habitats. On the barrier islands, however, no other non-grassland habitat is available to migrants. A critical research need in the Charleston Harbor area is to determine the habitat preferences of migrants. To accomplish this it will be necessary to sample habitats on the mainland simultaneously. It is possible that most migrants leave coastal scrub on the barrier islands to find favorable stopover areas elsewhere. As well as sampling bird populations, researchers should attempt to determine food availability in the habitats used by these populations.

Overall the early morning volume of migration through Charleston Harbor is about what is expected, based on numbers captured at other coastal stations in the southeast. For example, Sykes (1986) operated nets for 14 days on Cape Hatteras, North Carolina establishing a capture rate of 96.8 birds per 100 net-hr, as compared to my total of 114.0 per 100 net-hr. Farther south, on Jekyll Island, Georgia, D. Cohrs (Leake 1995) captured 144.8 birds per 100 net-hr. It therefore appears that volume of migration, as measured by a standardized trapping method, is

the same order of magnitude in Charleston as at other coastal stations in the southeast.

Taken together, the findings of this study suggest that the scrub habitat located on the barrier islands around Charleston Harbor may not be preferred stopover habitat for autumn migrants. The very low recapture rate of banded birds (3.3%) supports this contention. In the effort to compare different geographical areas, I attempted to capture as many migrant birds as possible. Netting effort was concentrated in the early morning: in this period of reduced light and wind, birds are most susceptible to capture. However, recent studies (Moore and Simons 1992) of stopover ecology suggest that migrants that have just ended a nocturnal flight may quickly leave the area of initial landfall if the habitat has low food availability or poor protection from weather and predators (Moore et al. 1993). The few migrants that do find the habitat suitable are often captured in the late morning, 3-4 h after sunrise (Hutto 1985). Qualitative midday observations around the banding sites suggested that few birds stayed through the day. Indeed, in contrast to the early morning "fall-out" of migrants, it was striking how few birds were seen in the vicinity of the banding stations after midday (pers. obs.)

The degree to which transient migrants use a particular site depends on their behavioral state;. i.e., reflects their state of migratory restlessness (Dingle 1980). Rappole and Warner (1976) observed that most individuals of species that arrive and leave in waves are restless, active, feed very little, and leave the area quickly. Indeed, only 4.2% of 1638 birds banded at Sullivan's Island and Folly beach were recaptured. A similarly low percentage was recaptured on Hog Island and James Island: 2.3% of 2851. By contrast, the recapture rate for nearctic migrants at a coastal station in Maine was 13.4% (Morris et al. 1996). This difference implies that the scrub habitat in Charleston Harbor is little used for a stopover by nearctic migrants.

For those individuals that do remain in this habitat, the average length of stay in the Charleston Harbor area is close to that reported from other areas. For example, Morris et al. (1996) found an average length of stay of 3.3 d on an island in Maine, as compared to my finding of 3.8 d on Folly Beach and Sullivan's Island.

The daily percent weight change of migrants that were recaptured on the island study sites was only +0.50% per day. This is considerably less than the +1.27% per day that Morris et al. (1996) found for 665 nearctic migrants of five species that were marked and recaptured on an island on the coast of Maine.
These authors found that migrants that gained weight more rapidly stayed in the same area for longer periods than did individuals that put on weight at a slower rate. They hypothesized that birds unable to gain weight at a sufficiently rapid rate could not effectively forage in the limited habitats of the island, and therefore after a initial short stay, switched to more favorable sites (see also Terrill and Ohmart 1984). Morris et al. (1996) further speculated that it is advantageous for migrants located at the edge of an ecological barrier such as the Atlantic Ocean to remain in one suitable foraging area until they have obtained sufficient fuel for a long-range flight.

These comparisons suggest that the island habitats that I studied were not favorable stopover areas for autumn nearctic migrants. This hypothesis is supported by my finding that White-eyed Vireos marked and recaptured at the inland stations showed a higher daily weight gain

(+1.63%) than did comparable individuals at the island stations (+0.74%).

Conclusions and Management Recommendations

I conclude that the disturbed coastal scrub habitat that I sampled, the most prevalent wooded habitat fringing Charleston Harbor, has relatively low value to migrant nearctic landbirds. This conclusion is based on the findings that: 1) after arriving in the early morning, few marked birds remain in this habitat; 2) the few birds that do remain stay for relatively short periods; 3) birds that are recaptured in the scrub habitat on the barrier islands gained weight at a lower rate than those recaptured in similar habitat farther inland; 4) an overwhelming majority of migrants are juveniles, many of which are probably off-course; 5) the most abundant species are relatively short-range migrants, that are already in or near their winter range (e.g., Gray Catbird and Common Yellowthroat). Therefore, high quality stopover habitat may not be as critical for them as it would be for migrants needing to refuel for continued overwater flights (e.g., Cape May Warbler, Black-throated Blue Warbler). These species composed a relatively small component of the avifauna.

Although disturbed coastal scrub *per se* may not be vital as stopover habitat in Charleston Harbor, my data do indicate that some geographic points have higher species richness than others. In general, the tips of barriers islands (Sullivan's Island and Folly Beach) had a greater variety of nearctic migrants than did ore inland stations. For this reason, it is recommended that these barrier island sites be preserved for research and education. At the present time both areas are protected by state and local government owwnership. Because of their limited sizes, these sites should be maintained as passive parks. Little management should be required to preserve their usefulness to autumn migrants.

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